Latent interference structure & observable state selection

In systems like

HD + DH

or

HD - DH

with H a Hadamard-like mixing operator and D a diagonal sign/modulation operator, the algebra already contains interference-like structure. But that structure is not yet “collapsed” into a concrete routing or gating decision.

The key issue is:

- additive superposition alone does not force commitment,
- while multiplicative observation does.

The matrices (HD) and (DH) represent two incompatible orderings:

- modulate then mix,
- mix then modulate.

Their sum/difference creates overlap terms that resemble constructive/destructive interference. But until some state-dependent multiplication occurs, the system is still linearly carrying all possibilities simultaneously.

A useful way to think about it is:

(HD + DH)

contains mixed pathways, but

(HD + DH)x

turns the latent interference pattern into an actual conditional operation.

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1. Interference Exists Before Selection

The sum

HD + DH

contains terms that reinforce or cancel depending on alignment between:

- the Hadamard mixing structure,
- the diagonal sign pattern,
- and the current vector state.

This is analogous to wave superposition:

- the waves interfere,
- but no outcome has yet been measured.

The system still evolves linearly.

In fact, if you repeatedly iterate such operators without nonlinear or multiplicative state interaction, the interference can remain globally distributed and reversible.

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2. Multiplicative Observation Creates Reality

Once the gating state participates multiplicatively, the situation changes.

For example:

(HD + DH)x

means the gate is no longer merely part of a superposed operator expression.

Now it actively modulates amplitudes.

This creates something closer to:

- pathway reinforcement,
- selective attenuation,
- conditional transport,
- or state-dependent energy transfer.

The gating becomes operational rather than descriptive.

This is similar in spirit to:

- attention masks,
- gain modulation,
- phase-sensitive detection,
- matched filtering,
- or quantum measurement-like projection.

The important distinction is:

> additive interaction creates possibilities,
> multiplicative interaction creates consequences.

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3. Why This Matters for Neural Architectures

This suggests a broader view of “activation”.

Traditional neural networks use local nonlinearities like:

$$y = \sigma(Wx)$$

where the activation function performs explicit pointwise collapse.

But in systems based on:

$$HD,\ DH,\ HD \pm DH$$

the interesting structure may already exist *before* any local nonlinearity.

The role of the nonlinear or multiplicative stage becomes:

- not creating complexity,
- but selecting among globally interfering transport modes.

That is a very different philosophy.

Instead of:

> local neurons deciding independently,

you get:

> global interference patterns becoming selectively observable through modulation.

This moves the architecture closer to:

- wave computation,
- holographic representations,
- spectral routing,
- resonant transport,
- and dynamically selected operator geometry.

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4. Hidden Interference Geometry

Another way to phrase it:

HD + DH

defines a kind of latent interaction geometry between:

- basis mixing,
- coordinate modulation,
- and transport symmetry.

But unless something multiplies by the resulting state-dependent pattern, the geometry remains implicit.

Multiplicative observation turns:

- virtual pathways
  into

- active pathways.

This is reminiscent of how interference fringes in physics are not directly useful until a detector couples to them.

The detector itself participates multiplicatively in the interaction.

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5. Relation to Affine Collapse

This also connects directly to the affine collapse discussion.

Purely additive linear combinations tend toward compressibility into equivalent affine forms.

But multiplicative gating prevents that collapse because the operator becomes state-coupled.

For example:

$$D_{\text{ⓗ}}Hx$$

cannot generally be reduced to a single affine transform because the operator $D_{\text{ⓗ}}$ depends on the evolving state.

Similarly:

$$(HD_{\text{ⓗ}}+D_{\text{ⓗ}}H)x$$

contains interference structure whose effective geometry changes with the observation/gating state itself.

So the multiplicative observation stage is doing two things simultaneously:

1. selecting among interference configurations,
2. preventing affine reducibility.

That is probably one of the deepest structural reasons these systems become interesting.